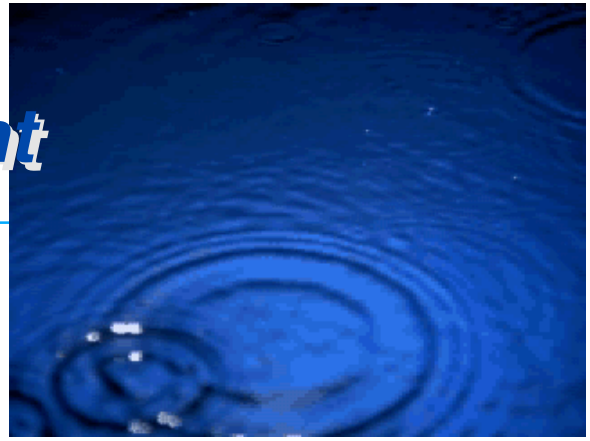
GPM

GLOBAL PRECIPITATION MEASUREMENT

GPM
Global Precipitation Measurement

Science Status Overview



Arthur Y. Hou
Project Scientist
Arthur.y.hou@nasa.gov

PMM Science Team Meeting
December 12-15, 2005
Monterey, CA

New administrator & HQ management:

Michael Griffin, Mary Cleave, Colleen Hartman

New GSFC Director:

Edward Weiler

Decisions on Precipitation Missions:

- **Extension of TRMM (Sept. '05)**
- **Approval of HF on GMI (Sept. '05)**
- **Approval of a joint Goddard-industry implementation of the GPM Core Spacecraft (Nov. '05)**

Community Support & Expectations

"The NASA Global Precipitation Measurement mission should be launched without further delays."

- Recommendation of the *National Research Council's Committee on Earth Science and Applications from Space* in hearing before the U.S. House of Representatives Committee on Science, April 28, 2005

"NASA will work to fund the earliest practicable launch date in the FY07 budget request." - NASA's response

"NOAA is already preparing for TRMM's replacement, the Global Precipitation Mission.. GPM will lead to 'better forecasts, better warnings, and better understanding of the hydrological cycle' said Gerald Dittberner of NOAA."

– *EOS* news article (Nov. 2, 2005) on NRC Committee on the Future of Precipitation Missions

Science Team Responsibilities

PMM Science Team plays a critical role in ensuring GPM's success through mission formulation & implementation phases:

- *Scientific guidance & oversight of the Mission*
  - *Providing scientific rationale for the mission*
  - *Defining the science requirements*
  - *Conducting scientific research to meet challenges in algorithm development, implementation, and validation*
  - *Developing innovative methods to improve data utilization*
- *Advocacy on behalf of the Mission*

Research responsive to mission needs

2005 GPM Science Highlights

- ***White paper on scientific rationale for GMI HF channels*** *(Kakar/Shepherd/Smith et al.), April 2005*
  - *GMI HF capability approval, September 2005*
- ***Establishment of GPM Advisory Panel on Ground Measurements*** *(Chair: C. Kummerow/Colorado State University)*
  - *First meeting (9-10 August), White Paper completed (30 September)*
- ***2nd International GPM Ground Validation Workshop, 27-29 Sept. 2005, Taipei, Taiwan***
- ***IPWG/GPM/GRP Workshop on Global Microwave Modeling and Rainfall Retrieval of Snowfall, 11-13 Oct., Madison, WI***
- ***U.S. National Academies Meeting on the Future of Precipitation Missions, 18-19 Oct., Washington, DC***
- ***5th GPM International Planning Workshop, 7-9 Nov. 2005, Tokyo, Japan***
- ***Development of L1/L2 Science Requirements & supporting Project's System Definition Review (SDR), 6-8 Dec., Greenbelt, MD***
- ***NASA PMM Science Team Meeting, 12-15 Dec., Monterey, CA***

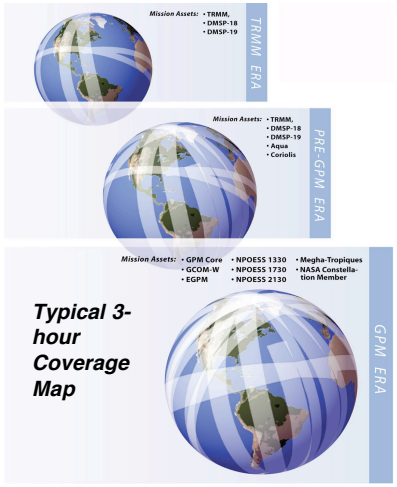
GPM's Dual Role in Global Precipitation Measurement

❖ A Reference Standard for Global Precipitation Measurement:

GPM Core Satellite will carry

- a dual-frequency radar &
- a microwave radiometer imager

to serve as *a precipitation physics observatory* and *a calibration system* for improving precipitation measurements provided by a heterogeneous constellation of dedicated and operational radiometers.



❖ Optimization of Global Sampling:

GPM provides a *"wild card" constellation satellite* to maximize the coverage and sampling by the constellation satellites.

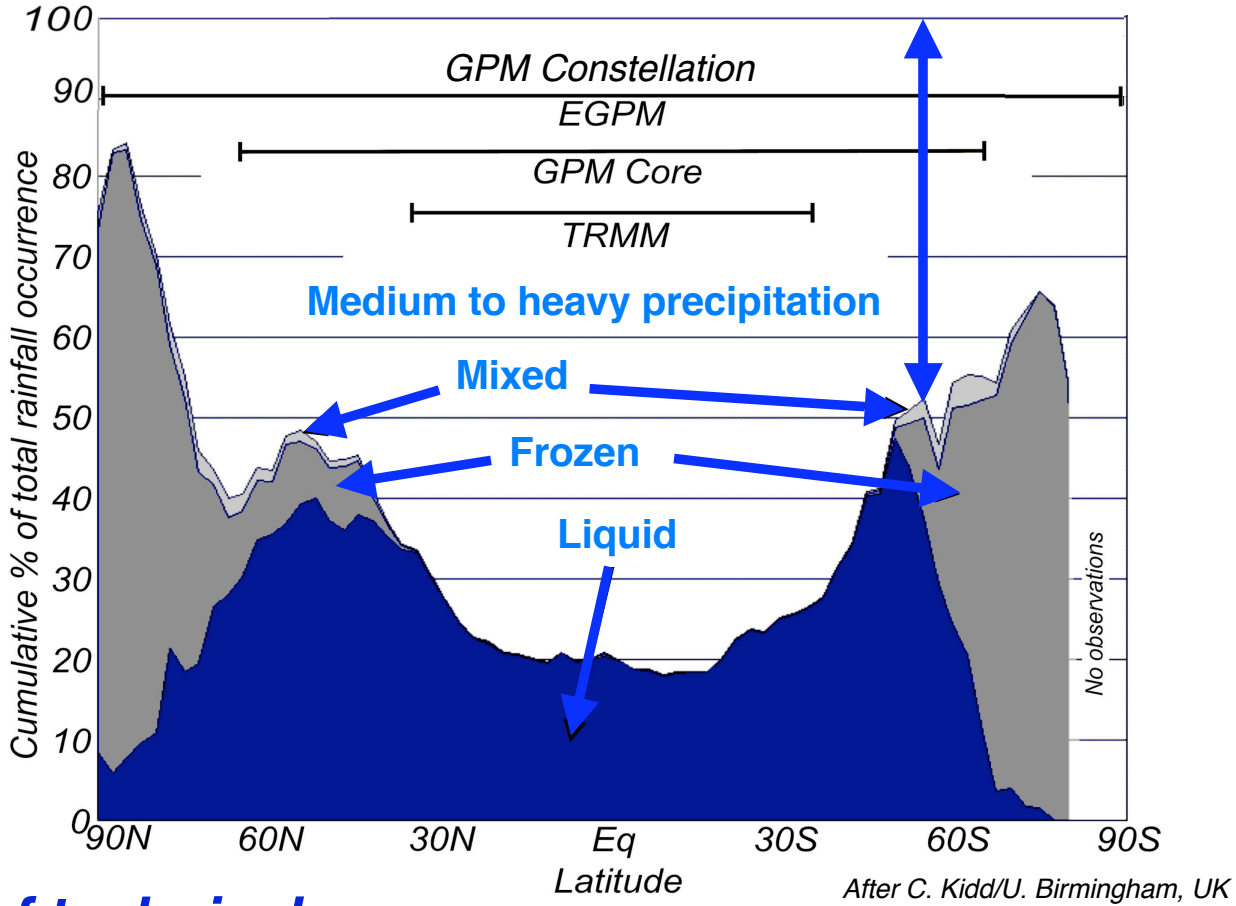
GPM Science Objectives

- *Advancing precipitation measurement capability from space:*
  - through combined use of active and wide-band passive remote-sensing techniques
- *Advancing understanding of global water/energy cycle variability and fresh water availability:*
  - through better measurement of the space-time variability of global precipitation
- *Improving weather forecasting skills:*
  - through more accurate and frequent measurement of instantaneous rain rates
- *Improving climate modeling & prediction capabilities:*
  - through better understanding of precipitation microphysics, surface water fluxes, soil moisture storage, and atmospheric latent heating distribution
- *Improving prediction capabilities for floods, droughts, fresh water resources, crop conditions, & other water-related applications:*
  - through improved temporal sampling and high-resolution spatial coverage

A science mission with integrated applications goals. Achieving these science objectives directly leads to societal benefits.

Measuring Light Rain and Snow & Better Precipitation Estimates over Land

Measurements of light rain (≤ 0.5 mm/h) and snow requires greater radar sensitivity than TRMM/PR as well as HF (> 90 GHz) radiometer channels

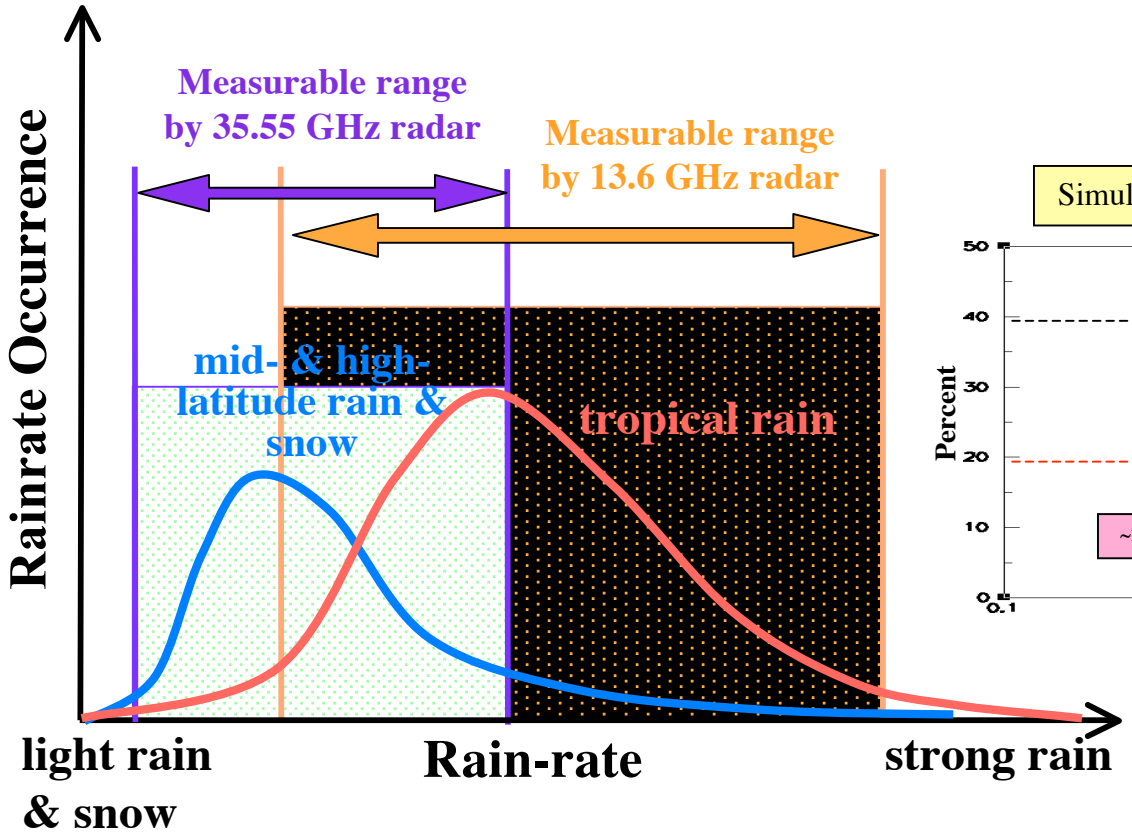


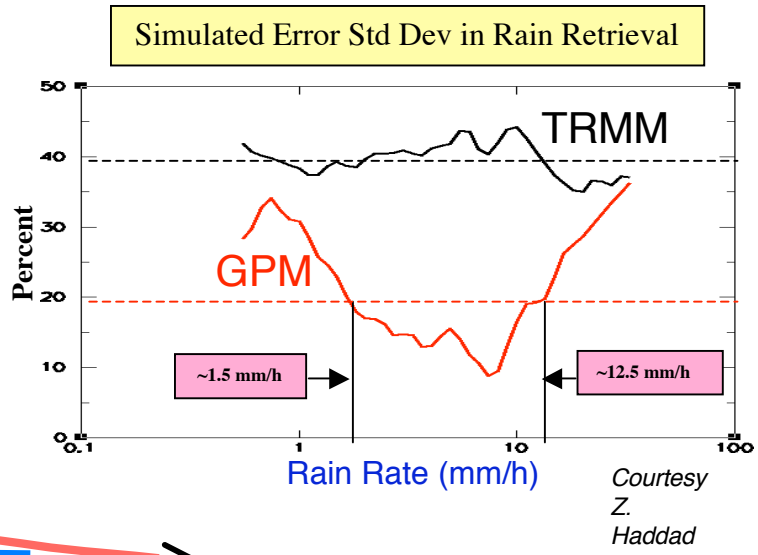
After C. Kidd/U. Birmingham, UK

In terms of technical capabilities GPM is NOT a global TRMM

JAXA/NICT Dual-Frequency Precipitation Radar

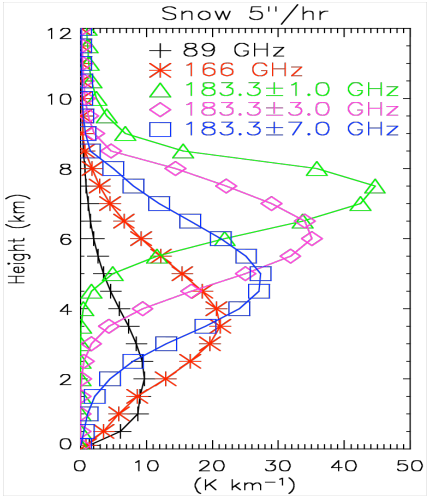
- ***Increased sensitivity for light rain and snow detection*** – *extending the detection threshold from 18 to 11 dBZ (0.5 to 0.17 mm/h)*
- ***Better overall measurement accuracy*** - *replacing the surface reference technique for path-integrated-attenuation correction with dual-frequency methods*
- ***More detailed microphysical information*** – *estimation of drop size distribution, etc. to improve DPR algorithms and Core & constellation radiometer retrievals*



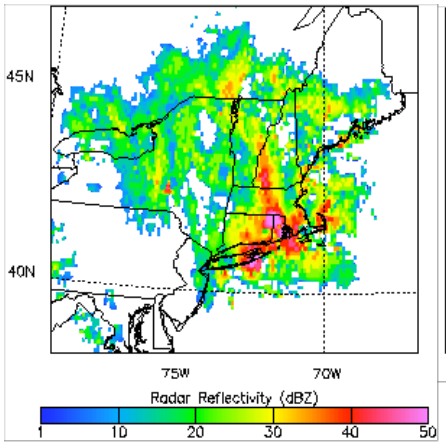


Science values of HF capability on GMI

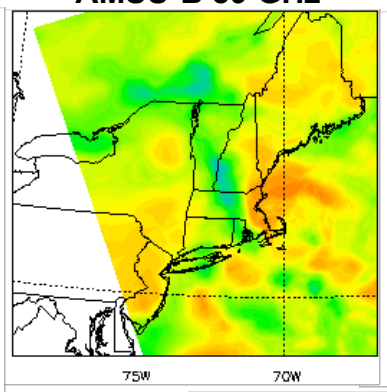
- ***Measurement of light rain***
- ***Detection of frozen precipitation***
- ***Improved retrieval algorithms over land***
- ***GMI HF channels on Core Spacecraft enabling the testing and evaluation of constellation radiometer algorithms using the DPR***



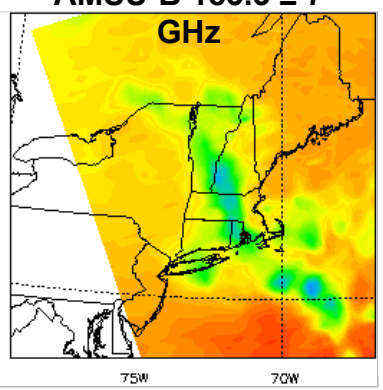
NOAA NEXRAD Data



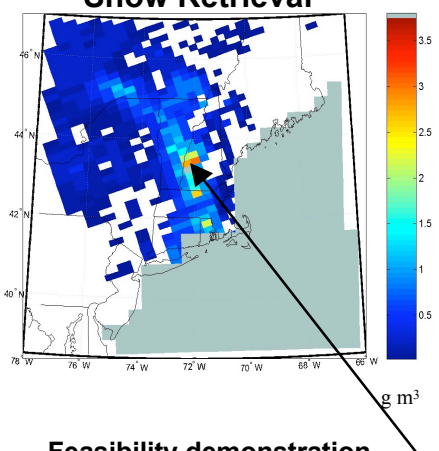
AMSU-B 89 GHz



AMSU-B 183.3 ± 7 GHz



Snow Retrieval



Radar reflectivity composite of the March 5-6, 2001 New England blizzard (75 cm of snow fell on Burlington, VT)

Surface effects evident over the Great Lakes, the St. Lawrence River, and along the Atlantic coast. Cannot distinguish surface from cloud effects.

Surface effects screened by water vapor. Snowfall appears over New England as low brightness temperatures

Feasibility demonstration of snowfall retrieval using HF channels 4 in/hr

G. Skofronick-Jackson et al. (GSFC)

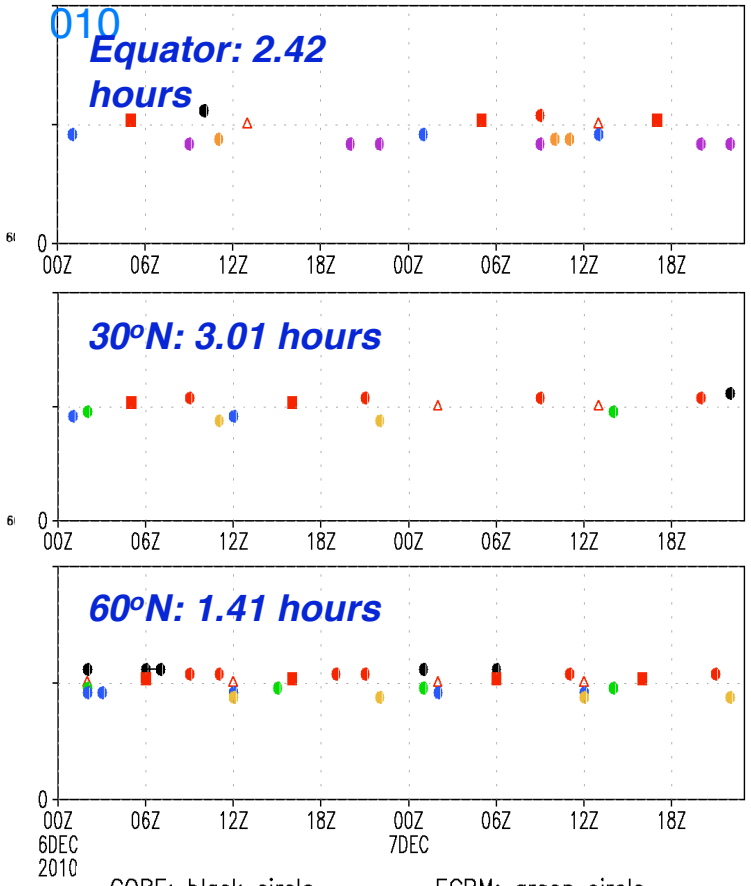
GPM Measurement Requirements

- ***(3.1.1) Discrimination between convective & stratiform precipitation types***
- ***(3.1.2) Measurement range*** *- 0.3 to 110 mm/ ... land and ocean*
- ***(3.1.3) Detection of snowfall***
- ***(3.1.4) Estimation of drop size dis... ...ating particles***
- ***(3.1.5) Estimation of 3-D late...***
- ***(3.1.6) Horizontal resolu... ...65°N and 65°S***
- ***(3.1.7) Vertical reso... ...ween 65°N and 65°S***
- ***(3.1.8) Coverag... ...verage revisit time of 3h or less over*** *80% of the g...*
- ***(3.1.9) A... ...neous surface rain rates*** *– biases ≤ 10% at 50 km res... ...calibrated ground validation data*
- ***(3.1.10) Pre... ...instantaneous surface rain rates*** *- random errors ≤ 25% at 10 mm... ...nd < 50% at 2 mm/h at 50 km resolution relative to calibrated ground validation data over ocean. Over land, the requirements relaxes by a factor of two.*
- ***(3.1.11) Error characterizations of instantaneous surface rain rates, associated radar reflectivity, and microwave brightness temperatures***

To be refined by the Science Team & supported with technical details in the Science Implementation Plan

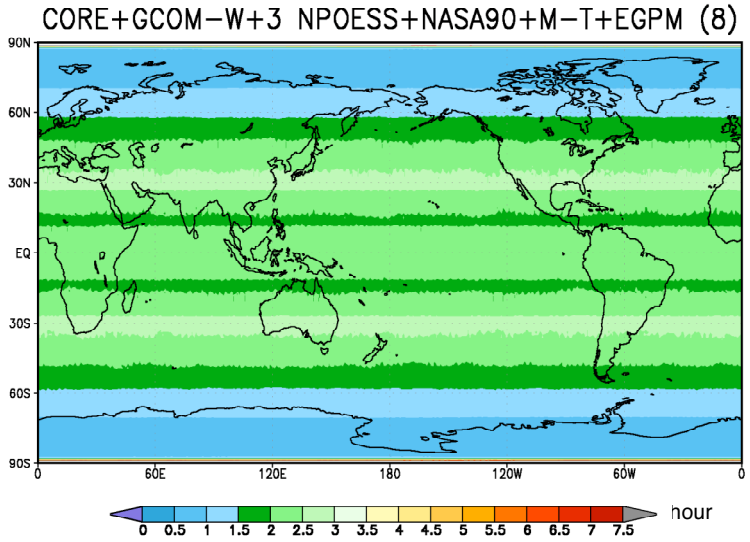
GPM science requirement: 3h revisit time over 80% of globe

Revisit times at 0 E: December 6-7, 010



CORE: black circle
NPOESS1: red circle
NPOESS2: red square
NPOESS3: red triangle
EGPM: green circle
GCOM-W: blue circle
NASA1 (Inc=90): orange circle
M-T: purple circle

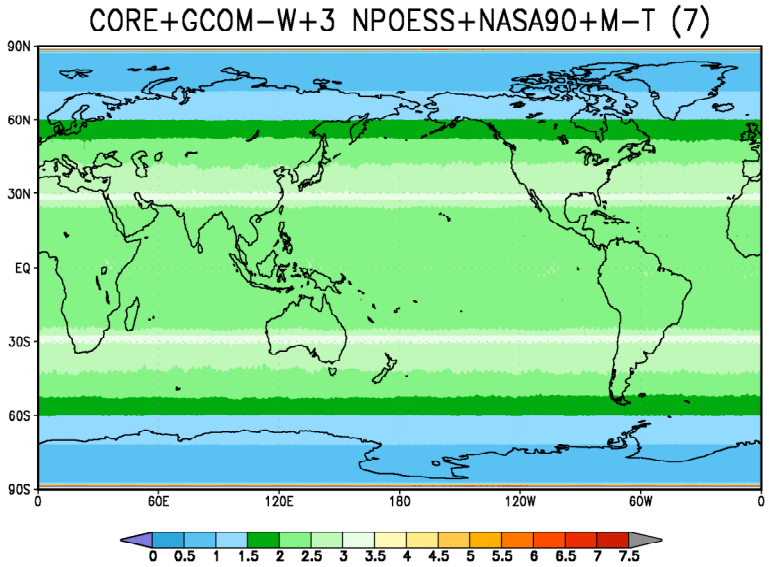
Expected GPM-Era:
(≤ 3h over 100% of globe)



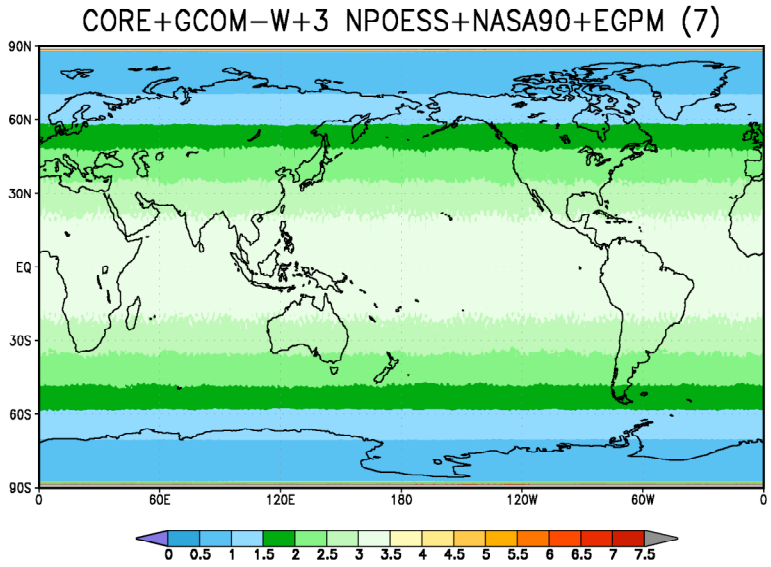
GPM Core, 3 NPOESS's, Megha-Tropiques, GCOM-W EGPM NASA-90º

Constellation architecture

Without EGPM:
(≤ 3h over 96.0% of globe)



Without Magha-Tropiques:
(≤ 3h over 64.7% of globe)



To Minimize the dependency on elements over which NASA has no control and to maximize the utilization of US assets,

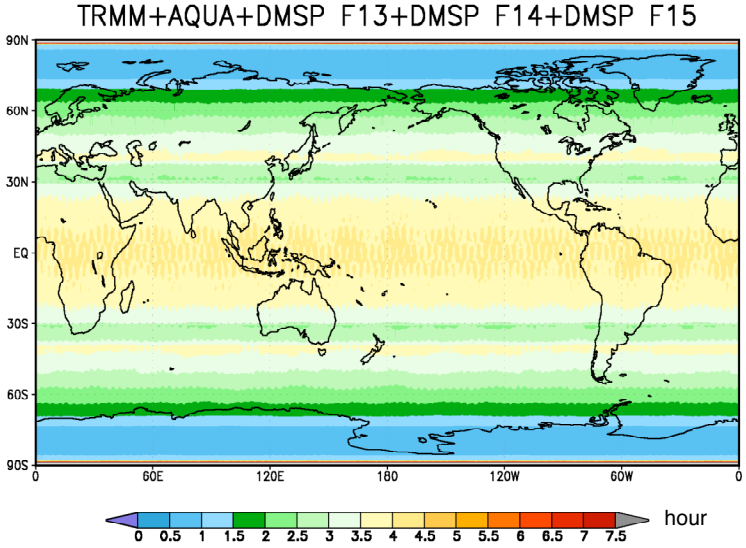
The GPM Project is taking a two-tier approach:

- Full Mission Requirements include all available constellation assets

- Base Mission Requirements with US-only constellation assets

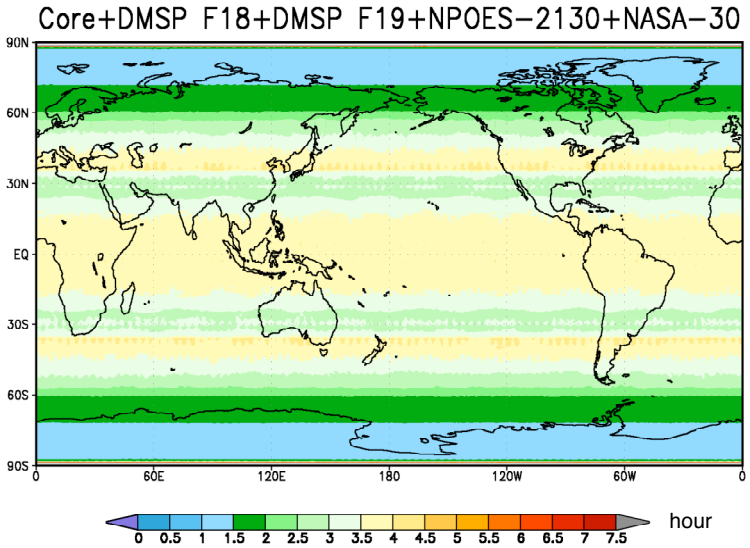
Is the "Base Mission" concept compatible with "Minimum Science"?

Current:
(≤ 4h over 91.0% of globe)



TRMM, Aqua, F13, F14, F15

US only constellation assets:
(≤ 4h over 98.2% of globe)



GPM Core, F18, F19, NPEOSS-1, NASA-30º

What are the minimum science requirements for GPM?

DPR-improved MW-radiometer precipitation retrievals with a global coverage equal to or better than the current sampling (4h revisit over 80% of the globe)?

What metrics do we use to define "minimum science"?

Revisit time? Spatial coverage? Sensor Capability?

Provisional GPM data product List

1. Level 1 Orbital Swath Brightness Temperatures From NASA Sensors (within ~15 minutes of observation at 90% of time)
2. Immediate Precipitation Products (e.g. 3-H[illegible] Outreach Precipitation Maps Continuously Updated as Data [illegible]
3. Level 2 Orbit Swath Products (sim[illegible] in 3h of Observation
4. Level 3 Grid Products
   (1) 1-hour @ 0.25 x 0.[illegible]ly @ 0.25 x 0.25 deg;
   (3) monthly @ 0.2[illegible]
   - Simplified [illegible]eter set:
   (1) surface [illegible] (2) convective-stratiform separation, (3) latent [illegible], bulk DSD parameters, (5) confidence index
   - Three [illegible]rieval products ordered by retrieval quality:
   (1) core (con[illegible] DPR - GMI) product, (2) constellation radiometer product, (3) microwave radiometer and sounder (e.g., AMSU, ATMS) product
5. Level 4 Merged Satellite Microwave-IR-Gauge and/or Merged MW-IR-Gauge-Model Products

To be refined by the Science Team & supported with technical details in the Science Implementation Plan

Top GPM Research Needs (to be expanded)

- ***Demonstration of the expected improvements in precipitation estimates using a dual-frequency radar relative to TRMM/PR***
- ***Demonstration of improved precipitation estimates using HF channels relative to standard frequencies – especially over land***
- ***Evaluation of the quality of precipitation estimates from MW sounders (e.g., AMSU) relative to MW imagers – over land and ocean***
  - *Examining the use of MW sounders to improve the sampling and coverage of imager-based precipitation products*
- ***Demonstration of how MW imager data improves merged satellite precipitation products***
  - *Error characterization of IR-only global precipitation products*
  - *Error characterization of TRMM-calibrated merged MW-IR precipitation products*
  - *Expected improvements from using the GPM constellation as a calibrator*
- ***Demonstration of the Satellite-Simulator-based validation concept for algorithm improvements***
- ***Quantitative metrics for determining precipitation data requirements for hydrological modeling/prediction at basin scales***
- ***Better assimilation methods capable of dealing with nonlinear physics and forecast model errors***

GPM Goals for This Meeting

- ***Review & refine L2 science requirements (Wednesday)***
- ***Recommend minimum science requirements (Wednesday)***
- ***Identify major science themes, challenges, requirements, and GPM deliverables for the Science Implementation Plan - tentatively five themes (see Wednesday agenda)***
- ***Review & refine GPM GV strategy, implementation plans, and integration with TRMM GV (Tuesday afternoon)***
- ***Formulate a coordinated algorithm development path towards determining standard (U.S.)GPM products (Tuesday morning)***

GPM enjoys tremendous support at many levels

But let us not be complacent

Our job is not done until the satellites are up and we have delivered on our promises.